# The American Biology Teacher

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**Emergence of NABT**

**The Quadrat**

**Radiation Biology**

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## Cover Photograph

This excellent dandelion photograph was sent in some time ago. We have no data or credit line to give because we have none. Will the NABT member who sent it please contact us so we can give him full credit? The photograph is just too good to keep in the files.

The Co-Editors

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# Items in the Emergence of the NABT*

OSCAR RIDDLE
*Plant City, Florida*

Yes, this Association has attained maturity. And I very greatly prize this chance to congratulate you. What is most pleasing is that you have movement and muscle in a time of urgent need. Yours is a part of an area of learning and of science that has become vital to our national strength—perhaps decisive for freedom in the West.

Before speaking on the subject that has been announced, I must first ask your leave to recall a few items of the pre-embryonic history of your Association. It may turn out that the two things are not unrelated. In fact, I can assure you that some events with which I was rather intimately connected during the last half of the year 1935 had much to do with the actual birth of this Association on July 1-2 of 1938.

In early August, 1935, an International Congress of Physiologists was held in Russia—four days in Leningrad, five in Moscow. There I could partly sense the vigor and strength, as well as the more obvious handicaps, of that nation's biological research. There, too, for a full hour in the Kremlin, Foreign Minister Molotov addressed Congress delegates on *educational* progress in the USSR; he told an amazing and doubtless exaggerated story. Surely, however, *education* was the Soviet accomplishment that he chose to exhibit to the visiting biologists. Also in Moscow, I witnessed the Annual Air Festival—clearly an exhibit of air power not yet shown by the United States.

Several weeks spent in other parts of European Russia assured me that mainly I was observing a sturdy and biologically gifted people, then rather crudely but effectively engaged in turning sharply away from its own long and somewhat indecisive history. At the great Dnieper Dam one saw the four huge dynamos early built for them by General Electric, U.S.A., but mostly one remembered the enthusiasm with which we were next shown the other four equally powerful dynamos more recently made and installed by Russians. And the large steel mill alongside this Dnieper Dam, in the midst of an entirely *new* city, well showed that Russian *industry* was on rapid march. In Yalta, on the Black Sea, one was near the encamped hordes of vacationing, youthful pioneers. Seeing their formal calisthenics, hearing their choruses, and observing them at play and in games, left no doubt that the new Russia prizes the child and is very effectively guiding the training of its youth. Clear, too, that those youngsters were not adrift—they were enthusiastically enlisted in the task of building a *great* Russia.

Having visited a swarm of biological institutes organized there within a dozen years, and having learned that, along with the other sciences, uncommonly large amounts of *unhedged* biology was then being taught in the secondary schools of the new and alien Russia, I returned to Paris at the end of September. There I chanced to pick up a recent copy of the European edition of the *New York Herald* in which the single long editorial was captioned " 'Evolution' not dead." But the editorial proceeded at once to *bury* it—in part with words which I now quote: "There are scientists who say that evolution is dead, and others that it is not. It is a matter of opinion, for as Darwin himself said, 'Evolution is a theory subject to future proof,' and there is still no proof today [sic]. . . . The controversy came up again at the meeting of the British Association which closed this week at Norwich. It was reopened at few months earlier by a physicist, Sir Ambrose Fleming, who in a presidential address to a meeting of scientists asserted that the Darwinian theory 'was the product of imagination.' . . . The issue has lost much of its passionate interest for the public. It is felt more and more that the theory of evolution is a question for scientists alone."

Thus a British physicist and the American editor of a daily newspaper in France coolly embalmed the heart and the soul of our science and neatly rejected the most vital and

*Remarks at the Twentieth Anniversary Luncheon of the Association, Washington, December 28, 1958. In this talk, Dr. Riddle describes the birth of NABT.

*penetrating* concept that the *whole* of science has as yet contributed to philosophy and man-freeing thought. The contrast with what I had just observed in Russia was clear and positive. This easy entombment could occur only as a response to underlying, but governing, religious sensibilities of Western peoples. Popular thought, community thought and power in the West today, combats no other prime concept of science as it everywhere and successfully does this basic and now well established principle. And this surely raises the question whether the socially indispensable fruits of the *life*-sciences, fruits whose sole worth usually rests upon their acceptance by a majority, will tomorrow ripen best to the east or to the west of the Iron Curtain.

Returning to my laboratory in suburban New York in mid-October I faced the extra-curricular task of preparing an address, as vice-president of AAAS (president of Section F), at its December meetings in St. Louis. I had already decided that the contacts and impressions which I have just recited to you must somehow affect the nature and content of that talk. In its final form that communication noted the unprecedented *enrichment* of the zoological sciences during the preceding thirty years. It urged that the *secondary* school is the center of hope for the survival of beleaguered and then seriously threatened democracy. It utilized U.S. Office of Education statistics to show that, instead of improving their always inadequate status, physics, chemistry and biology had all suffered *losses*, in terms both of amounts taught per high school pupil and otherwise, during that intensely creative thirty-year period. It especially emphasized the blighting circumstance that in every Western land biology, at the secondary school level, is a subject badgered and robbed of much of its strength and value by traditional *community* opposition and prejudice.

Included in my St. Louis audience was the president of the Union of American Biological Societies, the ancestor of our present AIBS. Within minutes he asked me whether I would care to form a committee that could operate under auspices of the Union and perhaps find something to do about the teaching of biology. I replied that the message he had just audited was part of my own resolve to try, from that day onward, to do something about that precise topic. By June, 1936, I had selected the members of such a committee. All of you have good reason to know them: Drs. E. V. Cowdry, F. L. Fitzpatrick, H. B. Glass, B. C. Gruenberg and E. W. Sinnott. We early decided to direct our effort wholly to the secondary school, to look toward the formation of a society primarily of and for high school teachers of biology, and ultimately, through questionnaire, to obtain some of the much needed facts about our subject. By the end of 1937 we had obtained from the Carnegie Corporation of New York a grant of $10,000 to which $500 was added later.

You should know that when, in April-June 1938, I wrote the then existing biology clubs of certain cities or regions a request that they send delegates to a meeting at which this Association would be formed in New York on July 1-2, I could offer to pay only one-half of their travel and hotel expense from committee funds. From that day onward there have been those among you ready to give much of themselves, as officers of the Association, or as heavy-duty operators of its journal. To them we are all in greatest debt. One further word can note that, following the formation of this Association and the resulting availability of its membership list, the committee of the Union could begin the preparation and circulation of its questionnaire on the teaching of biology in our high schools. To aid in this task, Dr. David F. Miller was appointed Committee Representative, and the fact-gathering part of that weighty task was accomplished in 1939-1940.

Incidentally, we do not here overlook the fact that the birthday of this Association came precisely eighty years after that July 1 on which Darwin and Wallace jointly announced the evolutionary origin of species to the Linnean Society of London. Thus this, your twentieth anniversary, is also the centennial of that thought-transforming event.

## Books for Biologists

LABORATORY OUTLINE FOR GENERAL ZOOLOGY, George Edwin Potter, 323 pp, $3.60. The C. V. Mosby Co., St. Louis, Missouri, 1958.

This manual has been planned and arranged so the order may easily be changed, and to give the elementary student of zoology sufficient guidance and practical directions for the laboratory study so that he will be able to go forward with the work intelligently without an instructor at his side constantly.

# Outdoor Laboratory Series — No. 5

## The Quadrat: An Approach to the Study of Ecology

ROBERT E. BROWN
*High School, Greenport, New York*

Measuring a quadrat.

Examining a soil specimen.

The quadrat, or the self-contained ecology study, has been the answer to our problem concerning a meaningful study of conservation. A quadrat is a staked out or measured plot of land, its size depending on the organisms being studied in it. Once the boundries of this plot are determined, the idea is to observe and record every living organism in it.

Our school is fortunate enough to be located in the midst of several contrasting plant succession stages. Our major concern was finding enough time to spend profitably in field work. This year we were able to obtain permission from our mayor to use city-owned land directly behind the school. These few acres contained swamp, weed, shrub, and climax forest stages.

Our primary purpose was to set up appropriately sized quadrats for the four major stages of plant recession: pioneer weed stage, shrub stage, temporary tree stage, and climax forest stage.

It was decided to use a two-meter square quadrat for our first ecological survey of the pioneer weed stage. In several indoor class discussions we covered what we might find in this quadrat.[1] We listed small mammals, insects, reptiles, arthropods, birds, etc., that we anticipated might live with one another in this quadrat. This, of course, brought out a detailed discussion of life cycles, interdependence of organisms, and, in short, the whole idea of what ecology means. This material was recorded and later duplicated for class use in review.

On the first clear day, following our very important preliminary work, we had our first field trip.[2] Most of this class period (45 minutes) was taken up selecting likely looking weed stages. Groups of students (four to a group) measured and staked out the quadrat. Since we planned to visit this particular quadrat for several days, small mouse traps were set and baited in an attempt to catch any nocturnal visitors.

The next day we re-visited the quadrat, this time set for some serious observing. Care was taken to keep out of the quadrats themselves as much as possible to avoid trampling areas. Using available materials such as sticks, knives, spoons and fingers, the students dug down several inches and sifted and sorted through the loam to find subterranean organ-

[1]Clues given in Benton and Werner's, "Workbook for Field Biology and Ecology."

[2]A note here to those unaccustomed to field trips: Be sure proper attire is remembered along with a specific purpose.

**Quadrat Data Sheet**

Locality______________________________________Date____________

Soil type__________________Soil temp.________________Quadrat No._______

Air temp.__________________________Vegetational type________________

| *Species* | *No.* | *% Area* | *Growth Type* | *Importance* |
|---|---|---|---|---|
| | | | | |

Notes and remarks:

isms. The various types of worms, arthropods, insects and slugs were recorded on observation sheets. We examined all of the vegetation and recorded the names of the grasses and weeds and the abundance of each. Unknown samples were collected for classwork identification. Unfortunately some young poison ivy found its way into the collection.

Not only were we on the lookout for actual "sightings" of organisms but also for clues indicating their presence in the form of gnawings, tracks, droppings, dust baths, nests, etc. Our slogan soon became "record every living thing above, on and under the quadrat." In some cases our numerous seagulls were enticed over particular quadrats so as to be enrolled in the census. One canine friend appeared on everyone's data sheet at least once.

Every rainy day was spent in analyzing what we had observed and collected. Food chains were determined, unknown specimens indentified and the general balance of nature discussed. This was also an opportunity to learn a bit about using insect keys, bird and tree indentification, and various soil types we had observed.

These stormy days were also used to advantage in discussing and determining what our next quadrat would include. Since we were concerned with the second step in plant recession, the shrub stage, it was decided we would need a larger quadrat, one about five meters square and we would be looking for different organisms. On the first clear day, armed with fresh data sheets and measuring rope, we established the second quadrat.

By using the stormy weather as well as the fair weather to advantage, we were able to have about two days in the field work and two to three in classroom analyzing. This proved to be ideal in our case, although, of course, this can be adjusted to meet individual class needs.

The results of this outdoor lab experiment, I am pleased to say, were gratifying. I don't believe I have ever seen a class with such a diversified science background build up as

A group working on a tree stump sample.

much enthusiasm for a project. I used this quadrat work purely as an experiment in two ninth grade classes, and I now plan to make this a definite part of our science curriculum. This seems to be a painless way of pointing out principles of conservation and ecology, and test results show most of the material to be meaningful and applicable to local conservation problems.

There are some faults with this outdoor program. There seems to be a lack of text information for students to draw upon, and as I indicated earlier, much of our material was developed from our discussions and observations and were later duplicated for class use. This fact puts an added burden upon the teacher who must search for methods and various bits of information he or she may need to carry on intelligent discussions in some aspects of the study. I relied upon several reference works,[3] plus a few plant and animal keys I had saved from my college nature study courses.

[3]Benton and Werner's "Workbook," and 'A Sourcebook for the Biological Sciences," by Morholt, Brandwein, and Joseph.

As is usually the case, I found my own enthusiasm for the outdoors "rubbed" off on my students, and when my spirit on some subject waned, theirs did also. The teacher's general attitude on discipline enters in here also. By not setting a definite group of goals to be accomplished each day at each quadrat, by not insisting upon complete silence in the field, by not standing over each group and dictating notes, we were able to develop a "free" attitude conducive to keen observation, one not found often in the classroom. Again this point, the situation, of course, will vary with class and teacher.

In conclusion, the quadrat ecology study is a technique suited to small school, classes of about twenty-five students, short class periods and an imaginative and resourceful teacher. In direct comparison to my former indoor conservation work, the quadrat method is very definitely a step in the right direction.

## CAREERS IN ANIMAL BIOLOGY

The popular booklet, "Careers in Animal Biology," has just been reprinted by the American Society of Zoologists. Originally published in April, 1958, this booklet was written for high school seniors and college students. The booklet describes job opportunities in basic and applied biological fields in schools, universities, research institutions, hospitals, government agencies, and industrial laboratories. It provides specific information about the duties of each position, kind of preparation required, opportunities for advancement, and salary to be expected. Sources of additional information about special fields are also listed. Copies of the booklet may be obtained from the Secretary of the American Society of Zoologists, Dr. Gairdner B. Moment, Goucher College, Baltimore 4, Md. The price is 25 cents for a single copy, or 10 copies for $1.50, 50 for $6.00, 100 for $10.00, 1000 for $80.

## Books for Biologists

ATLAS OF OUTLINE DRAWINGS FOR VERTEBRATE ANATOMY, 2nd edition, Samuel Eddy, Clarence P. Oliver, and John P. Turner, 105 pp., John Wiley and Sons, Inc., New York, New York, 1955.

This atlas has been prepared for those who desire unlabeled outline drawings to aid the student studying the anatomy of the dog-tooth shark, necturus and the cat.

# World Viewpoint in Health Education

LUTHER S. WEST
*Northern Michigan College, Marquette, Michigan*

The high school teacher is frequently called upon to give instruction in health science, either as an integral part of the biology course, or in some other curricular relationship. More than ever before in American history, the present high school student faces the prospect of someday living in a foreign country and facing whatever health problems may be involved. Military service, employment under technical assistance programs, or connection with various commercial and industrial enterprises are common experiences today, in addition to student exchange arrangements and educational or recreational tours.

What preparation is the adolescent now receiving that will (1) make him continually conscious of the health hazards in a tropical or unsanitated area? (2) equip him with the knowledge necessary for taking intelligent, personal precautions? (3) give him some knowledge of health organization on a world basis, in order that he may know where to turn for guidance and information in a particular situation or geographical area?

I became acutely concerned with this problem a few years ago, in connection with summer teaching of high school faculty personnel. It was apparent that content of high school courses is inevitably weighted in the direction of the teacher's previous preparation, and it seemed evident that a real lack of preparation in certain aspects of health science was almost universal.

Under a Faculty Research Fellowship, I was able to conduct an investigation into the literature most likely to influence the teacher of high school science during his preparatory years. Three classes of health literature were scrutinized.

1. Health textbooks used directly or indirectly in connection with courses intended for *all* college students. These are usually taught at the junior college level under such titles as Effective Living; Personal Living; Healthful Living; or Personal Hygiene.

2. Textbooks and other documents used in connection with courses in Health Education. Such courses are usually offered at the senior college level and are taken principally by candidates for *teaching credentials.*

3. Theses and term papers prepared by *in-service teachers* for graduate or certificate credit and filed as library material. Titles of these items are particularly useful indicators of the direction in which the health interests of active teachers have been slanted, either by instruction received or through community experience.

### Parasitic Diseases

Certain groups of diseases, though not statistically important in the United States, are of vast significance, both as to mortality and morbidity, in other regions of the world. Particular interest attaches to conditions caused by animal parasites and to infections transmitted by arthropods. Malaria, African sleeping sickness, kala azar and relapsing fever fall in both these categories. By knowledge of such infections, the student acquires an international attitude regarding personal and public health. Without such knowledge a world health viewpoint is virtually impossible.

Nine leading college textbooks were analyzed to determine the extent to which parasitic and arthropod-borne diseases are given recognition in these "American bibles of health science." Space does not permit an explanation of the tabular methods employed, but the summary reads as follows: "Of the nine textbooks analyzed, only two, or 22 per cent, make any mention of world health interest in preface, foreword, or introductory chapter. Of the total of 289 chapters, only 19, or 6.6 per cent have content bearing either on parasitic (or arthropod-borne) diseases, or on world health in any relation whatsoever."

Turning next to literature in the field of health education, the picture is no more encouraging. Again nine volumes, somewhat diverse in character, were analyzed. Produced within the past twelve years, these should have reflected any possible war experience of the authors and should have shown any trend

**Analysis of 22 Research Papers by Graduate Students and/or Teachers on Materials for Health Education**

| Numerical Designation | Author Identif. | Title | Total No. Pages | Total No. Bibl. Ref. | Pages Ref. W.V.*** | Pages** Ref. P&A-BD* |
|---|---|---|---|---|---|---|
| 1 | E.E. | Health Contributions of a School Camping Program | 20 | 18 | 1 | 0 |
| 2 | D.A.S. | Health Teaching in the Secondary Schools | 17 | 9 | 0 | 0 |
| 3 | C.C.M. | Opportunities of Improving Health Education in General Science | 23 | 9 | 1 | 0 |
| 4 | E.P.Z. | Health Experiences of Some Elementary Teachers in Washtenaw County | 19 | 48 | 0 | 0 |
| 5 | H.M.L. | A Critical Appraisal of the Health Program . . . in the Public Schools of Grand Rapids | 15 & exhib. | 13 | 0 | 4 |
| 6 | R.P.S. | Helping Boys and Girls to Keep Healthy (Unit for First Grade) | 22 | 13 | 1 | 0 |
| 7 | W.P.T. | The Role of the Classroom Teacher in Total School Health | 25 | 9 | 7 | 3 |
| 8 | G.I.M. | Health Education in the School Camp | 7 | 0 | 2 | 3 |
| 9 | B.W. | Health Education Appraisal of the Public Schools of Port Huron, Michigan | 13 | 6 | 0 | 0 |
| 10 | L.R.V.O. | Proposed Health Program for the Summerfield Township School | 14 | 5 | 0 | 0 |
| 11 | J.B. | A Comparison of the Health Program of Moccasin School Buchanan with . . . | 18 | 16 | 0 | 0 |
| 12 | J.C. | Social Studies—A Vehicle for Health Teaching | 22 | 11 | 3 | 0 |
| 13 | F.Y. | A Latin-American Health Education Program (in Arizona) | 12 | 15 | 1 | 0 |
| 14 | O.M.E. | Healthful Living (Unit for First Grade) | 8 | 15 | 0 | 0 |
| 15 | M.M. | What I Can Do to Improve and Maintain Good Health | 18 | 44 incl. posters | 0 | 0 |
| 16 | R.B.K. | Demonstration Experiments for Health (Grade 6) | 19 | 9 | 0 | 0 |
| 17 | G.W | A Suggested Health Program for the Seventh through the Twelfth Grade | 29 | 16 | 0 | 0 |
| 18 | Q.G. | School Health Manual | 21 & Exhib. | 25± as Exhib. | 0 | 1 |
| 19 | F.P. | The Health of the Teacher and the School | 18 | 10 | 0 | 0 |
| 20 | R.G. | We Study Ourselves (Sixth Grade) | 13 | 20 | 2 | 1 |
| 21 | L.McC. | A Program of Health Teaching (Fifth Grade) | 31 | 15± incl. juv. | 0 | 0 |
| 22 | Staff of W.D. School | Health Teaching through Life Experiences | 19 | 0 | 3 | 5 |

*Parasitic and arthropod-borne Diseases

**By "page" is meant the equivalent of 8½ X 11", typed, double space

***World viewpoint

toward greater recognition of an international point of view.

Since this class of literature is concerned somewhat more with methods of teaching and with the development of attitudes, than with basic, factual health knowledge, our analysis must necessarily be along somewhat different lines than with health texts for college students. We are here concerned particularly with the type of subject matter that the author brings forward by way of *illustrative material;* also, with the *attitudes* and *objectives* which the author considers it desirable to achieve, in working with children and adolescents.

Summary in paragraph form proved a more just method of evaluating this material than tabulation of pages and chapters. A typical example is given herewith:

#### Analysis of a Selected Title

*Identification; Nature and Scope of the Work* (Code Number identifying author), *School Health and Health Education, with Special Consideration of the Teacher's Part in the School Health Program*, 2nd Ed., 472 pp., St. Louis, The C. V. Mosby Company, 1952.

In twenty-one chapters the author discusses school health programs, actual and desirable; types of personnel concerned with school health problems; diseases and defects; planning techniques; functional procedure; special place of hygiene, physical education, and safety; opportunities at different grade levels; sources of material; community relations; appraisal of results.

*Relation of Content to World-Health Interest*
There is definite mention of military duty, and statistics are presented regarding the health of foreign children. Parasitic diseases, such as ringworm and scabies are given usual attention, also the relation of lice to specific, infectious diseases. The correlation of health teaching with other subjects such as geography and history is given mild support. The discussion is very brief. Community health services, such as water supply and sewage disposal are treated from a local standpoint.

*Objectives Promoting World-Health Attitudes*

Nowhere in the preface or introductory matter is there a statement of objectives with a bearing on world health. There is, however, a special chapter listing the objectives of health education. Objective 13 treats of group control methods in preventing malaria and helminth infection; objective 88 includes safe preparation of pork and objectives 107-120, stressing sanitation, include many references to parasitology and medical entomology. Objective 141 has to do with the child's curiosity concerning the world *about* him. Statement that health education should convey "benefits felt by the individual *throughout his whole life*" fails to add "*wherever he may go.*"

The third category, "Health Interests of the In-Service Teacher," was studied from research papers prepared in connection with the University of Michigan's graduate course, "Materials for Health Education."*

The writings of these graduate students ranged the entire health field, and some elimination seemed desirable. Papers dealing specifically with *Narcotics, Nutrition, Legal Aspects of Teaching, Rheumatic Fever, Hospitalized* and *Handicapped Children, Safety, Grooming, Venereal Disease* and *Alcoholism* were not considered in this study. Twenty-two papers were selected, titles of which seemed to indicate a less restricted point of view. An analytical table is reproduced herewith.

#### Comment on Tabular Data

In crediting reference to "world viewpoint," a liberal interpretation has been followed. For example, if mention is made of sanitation, especially with reference to water supply, waste disposal, care of garbage, etc., world application is assumed, and the page credited in this column, even though the writer may not have been conscious of having a world outlook. Anything relating to epidemics usually qualifies, as would mention of the work of the Red Cross.

A more rigid interpretation has been followed for P and A-B D (parasitic and arthropod-borne diseases). Actual mention of amoebic dysentery, worm infection, scabies, tick problems, spider bites, or mosquito control (as in camping) is credited without question, but broader statements are considered to apply only when they indicate that a parasitic or arthropod-caused condition was in the writer's mind.

Reference to food being transported long

*Thanks are due to Dr. Mabel Rugen, University of Michigan, School of Public Health, for permission to use her files.

distances is considered appropriate; likewise, recognition of the historical importation of foods from other continents or latitudes. Utilization, in a school health program of the experiences of parents or entire families who have traveled abroad, definitely indicates an interest in world health problems and always engenders an appreciation of geographical differences in the minds of the children. The great importance attached to inoculations against cholera, yellow fever, and typhoid, while traveling, serves to underscore the value of similar preventive measures against whooping cough, diphtheria, and tetanus, here at home, and thus serves more than one educational objective.

By such broad interpretation, therefore, we are able to find some evidence of concern with world health problems.

Even so, of 403 pages of manuscript relating to health education only 21, or 5.2 per cent make even casual reference to a world health viewpoint, and of these 21, seven occur in the same manuscript! Parasitic diseases, arthropod-borne conditions, or medically important arthropods are mentioned on 17 of the 403 manuscript pages, a percentage of 4.2.

More significant perhaps, is the fact that of the 22 papers analyzed, 13 make no mention of world health, even by implication, 16 nowhere refer to parasitic or arthropod-borne conditions, and 11 make no reference to either.

If these findings represent the extent to which in-service teachers have been trained in, or are now concerned with, a world-health viewpoint, the situation would seem to constitute a challenge. The most hopeful program for correcting this deficiency seems to be by way of graduate courses which cover broadly the basic principles of public health. The University of Michigan and Northern Micnigan College have had considerable success with courses of this character.

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# About Algae

HERMAN S. FOREST
*Memorial Research Center, University of Tennessee*

As a biologist who has specialized in the study of non-marine algae, I most warmly recommend those colorful organisms to the student and teacher of general biology. My original reason for studying them was that they provided me an excuse to be around rivers, lakes, and wet cliffs. After twenty years, the excuse is still as good. There was another reason, one that as an undergraduate student I found difficult to discuss: I wondered if these simpler organisms could provide access to investigation of some of the big problems of life, such as the course of photosynthesis and the origin and changes of life. While I have not solved any of the big problems, the study of algae has continually opened doors into wider experiences in biology. Algae can enrich your experience, too.

"Algae" is a rather vague category. You have known them as sea weeds, pond and aquarium scum, and "water moss." Most are small and relatively simple in structure, most contain some chlorophyll, most reproduce sexually, most live in water. I am forced to say "most," because there are exceptions to all of these facets. In the "group" called algae by early investigators, the more critical modern mind finds organisms which differ from each other more than ferns differ from cacti. Nevertheless, at the nature study level, "algae" is a useful term. Without a hand lens you can tell the difference between a bryophyte, which appears to have little leaves, and a coating of algae in which little or no structure is discernible.

Moss protonema, of course, looks like algae. Well, why isn't it algae? Here is a good chance to put in a word for developmental biology, or even the dreaded life cycle. The desirability of taking a closer look at life might be raised too, and an introduction made to cytology and physiology.

I recall the glow of professional pride that I quickly developed when a middle-aged business man told me that he remembered only one thing from his biology course—*Spirogyra.* There is some aesthetic as well as utilitarian appeal about it. On the useful side, it is one of the best subjects for demonstrating plasmolysis and will dutifully produce oxygen bubbles in bright light. A wad of *Spirogyra* or other algae often helps make a microcosm work too.

Algae would probably respond well and quickly to different fertilizers in a mineral nutrition demonstration.

In the study of sex and reproduction, *Spirogyra* is a standard in many classrooms. My own success with it has been limited when I expect students on their own initiative to figure out what is happening. Yet, it *ought* to be good; in plain sight are gametes and zygotes, N and 2N generations, and movement of the protoplast which may not be seen but is inferable. Within the algae is the whole gamut of gametic evolution from isogamy to heterogamy. Plus and minus *Chlamydomonas* strains will conjugate immodestly under the microscope, and *Oedogonium* eggs can be seen, although the sperms are illusive.

It was the systematics of algae that held my interest at first. While I do not think that the specific details of this pursuit belong in a general course, the algae serve to illustrate the difficult process of classifying. Really, what does this group have in common anyway? Who decides what constitutes a "natural" group? Do blue-green algae have more in common with bacteria than with other algae? What is the relation between evolution and classification? If diatoms move, why are they not animals?

Any study of evolution should include mention of algae. Their ancient lineage, their great development in the seas, the half dozen or more fundamentally different groups, and the probable rise of land plants from the green algae are all meaningful subjects.

Yet, it is the ecological outlook that is perhaps the most intriguing in algae, as in biology generally. The relationships in the communities where algae live are infinitely interesting. At the simplest level, where can you find algae? You may find them almost anywhere, including in the air. Certainly, numbers of them will be found in the soil. Culturing to reveal their presence requires only light (50-500 foot-candles), a moderate temperature, and moisture in air and substrate. Trying to determine where the "growth" comes from can raise questions on biogenesis, sterilization, and procedure for "proving" an event.

Energy exchange in the biotic community can be studied well in a drop of stagnant water which contains rotifers, protozoa, and bacteria, as well as algae. The highly heterogeneous community of a jar of pond water can illustrate the evolution of a community, and the differing relationships among organisms—competition, co-existence, and aid.

For the young investigator, I suggest that my original reasons for interest in the algae are still worth your consideration. We have learned precious little in the last twenty years, even though the Sunday supplements would have their readers believe that the overpopulation problem is solved by feeding everyone algae. Much of the systematics of algae is ancient and based on limited numbers of specimens so that orderly minds and intense effort are needed in taxonomy. Many fundamental problems in growth could be approached through study of the algae, which are good green plants, and yet require no greenhouses, and can be handled with ease. The role of algae in the soil community is almost an unplowed field into which my students and I began to dig only three years ago. The genetics of non-nucleate cells, such as those of blue-green algae, is one of the great unknown fields of biology, and one that may be enormously revealing of the fundamental properties of life. There are no ready answers.

However, for a start, I do have a few suggestions. The principal investigators of algae, which include many foreign members, are organized into the Phycological Society of America. If you write the secretary, W. A. Daily, Biology Department, Butler University, Indianapolis, Indiana, he may suggest the name of the nearest member of the society to you. If the member has time, he would probably enjoy talking with you about algae. Cultures of single species of algae can be obtained from the Algae Culture Collection, or Dr. Richard C. Starr of the Botany Department, Indiana University, Bloomington, Indiana. A list of the algae available is published, and the cost is one dollar a culture.

There are many books on algae. Some of them are mentioned in an article which I

wrote a few years ago just to introduce the subject. Reprints of "A Primer in Algae," are available, single copies will be sent on request, larger numbers at a small cost. G. W. Prescott's book on algae in the Jaques Series, W. E. Brown Co., is a beautifully illustrated key to common genera, and his "Algae of the Central Great Lakes Region," Cranbrook, is perhaps the most comprehensive work to the species level in the English language.

# The Story of the Ammonites

## (Their Significance for the Study of Evolution)

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*It is much more remarkable that, among these shells, the relative velocities of growth in various dimensions should be as constant as it is, than that there should be an occasional departure from perfect regularity.*
—D'Arcy Thompson, 1917.

Aside from their interest as museum curiosities and their great duration in the past, the the ammonities have had a remarkable influence on the study of evolution, particularly on the problem of recapitulation. However, the implications drawn from a study of their curious nature should be evaluated carefully.

The commonest ammonite was a spiral shell in a single plane, resembling somewhat a coil of rope. Its peculiar structural variations are illustrated in the accompanying figure.

The ammonites once attained a world-wide dominion, beginning in Upper Silurian times until their rather mysterious extinction toward the close of the Mesozoic era. Their five thousand species ruled the seas for something like 250 million years, truly a successful and remarkable dynasty. They were, of course, the most advanced of the Mollusca.

I first met them several years ago while traveling high in the mountains of central Afghanistan. It was during my sojourn as a biology teacher in the capital city of Kabul. While enjoying a holiday I crossed the magnificent Hindu Kush range that bisects that part of the world. On the surface of a mountainside more than a mile above sea level I stumbled across several calcareous remains of these strange creatures of the deep.

One may easily mistake the museum of variety of ammonite for the "chambered Nautilus" that Oliver Wendell Holmes immortalized as the "Ship of Pearl." The Nautilus is a relative belonging to another order of Mollusca, however, and appeared in an earlier age.

The ammonite shell is coiled like a watchspring, and it is divided by septae (partitions) into compartments. These are the primary structures which arose from a shell gland that is common to all forms of Mollusca. The shell became, for the developing ammonite, its calcareous home, made of an external imbricated layer of aragonite, and an inner mother-of-pearl layer. It also became a unique biography of its tenant. As the animal developed, it moved to successively new quarters, secreting a new wall behind it and making a permanent record of past vicissitudes.

The differences between the Nautiloidea and the Ammonidea lay in the design of the ambulatory sac. This gadget allowed the animal considerable power to leap and swim by forcing water violently through this sac. The pecularities of its anatomy formed a continuous record of structural modifications.

The characteristics which concern us here are the curious suture lines which marked the location of septae. They increased in complexity with geologic time. Ammonite specimens taken from late Paleozoic strata, as a rule, show fairly simple, moderately curved lines. Generally speaking, there are three suture types as shown in figure 2. First, the "goniatite," of smooth and simple lobes and saddles, was characteristic of the Devonian and Mississippian periods. It disappeared in the late Pennsylvanian and Permian ages. Secondly, the "ceratite," with smooth saddles and

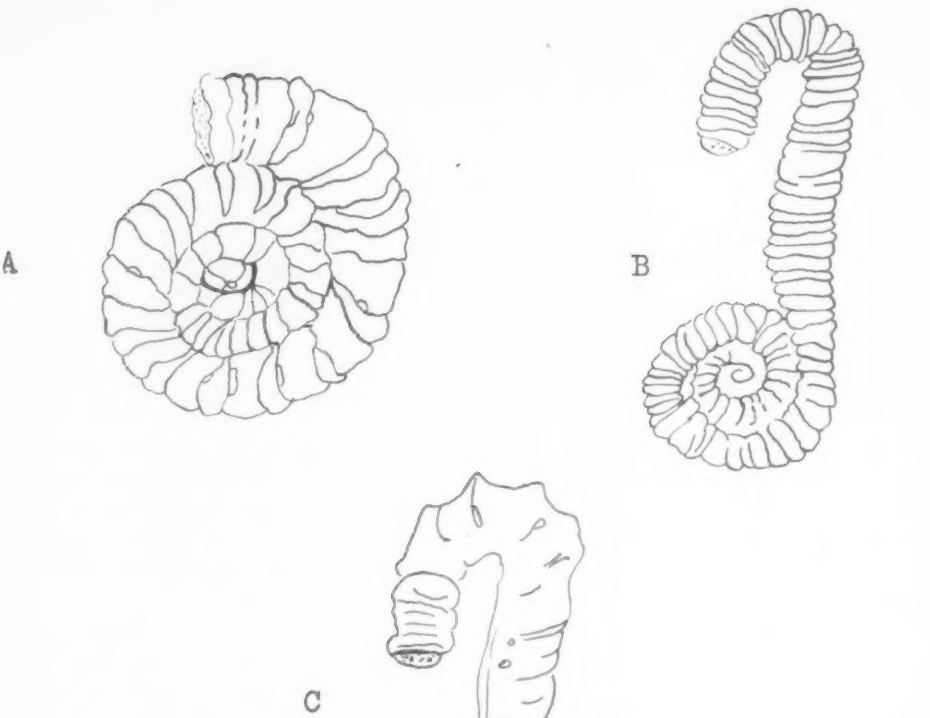


Figure 1. A few typical ammonites. A, the "normal," or usual, simple, coiled type. B-E, some unusual forms (Simpson 1949:202).

crumpled lobes, flourished from the Permian through the Triassic periods, covering some 67 million years. Lastly, the "ammonite" type, with crenulated lobes and saddles, produced a dendritic effect. One might fancy a resemblance here with the beautiful arborizations of cerebellar Purkinje cells.

Now these suture lines are most intriguing; they are relatively straight in the older parts of the shell, and then they undulate near the periphery.

Their complexity began in the late Paleozoic and reached a pinnacle in the Mesozoic era, forming, as it were, prehistoric finger-

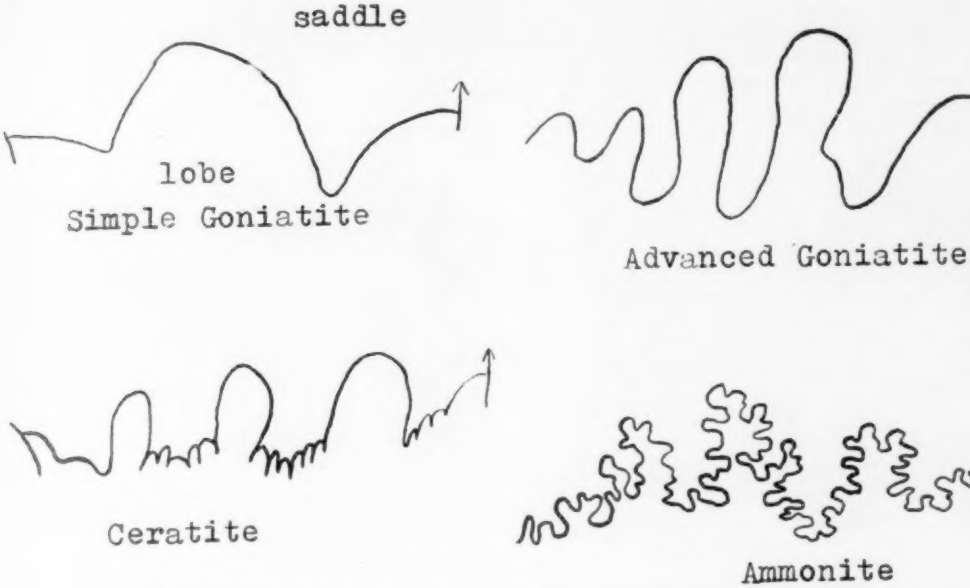


Figure 2. Typical ammonoid sutures (Croneis and Krumbein 1936:419).

prints, to identify the creature and the age in which it thrived. This ontogenetic increase in suture complexity when correlated with the geologic record has been the basis for the assertion that these ancient Cephalopods tend to recapitulate for us the life history of their ancestors. It is said the young stages of Mesozoic shells recapitulate the adult characteristics of Paleozoic forms.

> "In other words, *Nautilus pompilius*, like most Cephalopods, in its individual growth crudely recapitulates or summarizes some of the stages through which its ancestral stock has passed" (Croneis and Krumbein 1936:418).

Many biologists have been unduly charmed by such thinking as this. A late nineteenth century example was the biologist Hyatt 1893:369-370). So intrigued was he by these remarkable creatures that he devoted to them an entire monograph which he called "Phylogeny of an acquired characteristic."

> "The contemplation of the wonderful phenomena presented by these (creatures) has finally led the author to the conclusion that the phenomena of evolution in the Paleozoic were distinct from those of later periods, having taken place with a rapidity paralleled only in later times in unoccupied fields" (pp. 369-370).

Hyatt was saying simply that the conditions characteristic of the Paleozoic era alone caused variations to appear in the adult which were pushed back into the earlier stages of ontogeny.

> "If we examine any of the progressive series, we find that characteristic modifications of variations tend to appear first in the later stages of growth and, as a rule, in adults; then in successive forms of the same genetic series they tend to appear at earlier stages of the ontogeny and finally they often disappear altogether or become embryonic, and this is the case also with the degraded characteristics" (p. 372).

Coming as it did at the end of the nineteenth century, his memoir shows clear evidence, as suggested by the title, of his belief in the inheritance of acquired characteristics, the view that had such a significant following during his time.

Thus it is not difficult to understand Garstang (1922:92) who wrote that when he had often been tempted

> "to attack a theory which had led . . . into blind alleys . . . always Hyatt's ammonites recurred to present an unanswered, and seemingly unanswerable case for Haecklian recapitulation."

However, the simple explanation given by Hyatt, and again by the recent writers, Croneis and Krumbein, that the suture lines mirror ancestral developments, has not been accepted quite so easily in some quarters. In his important little book, "Embryos and Ancestors," de Beer (1940:50-52) makes a telling observation:

> "The schemes of phylogeny presented by Hyatt . . . present the following situation. *Microceras densinodus* has a spirally wound shell of which the four inner whorls are smooth, the next two are ribbed, and the outer whorls are knobbed. The inner whorls are, of course, the earliest to be

formed, and so the animal has passed successively through ontogenetic stages in which the shell which it made was first smooth, then ribbed, and lastly knobbed. On the theory of recapitulation, to quote Lang, 'it is supposed that the ancestral form had a plain shell and that during its evolution the stock or lineage from which *M. densinodus* arose acquired, first a ribbed, and then a tuberculate ornament.' . . . Now, why should the ribbed-shelled stage in the ontogeny of *M. densinodus* represent an ancestral adult stage? That ancestor may have had a ribbed-shelled early ontogenetic stage, but there is no evidence at all of what its adult state may have been like. Indeed, in some species of *Psiloceras*, Spath has shown that the ribs make their appearance in phylogeny in the inner whorles, i.e., in the early stages of ontogeny. After presenting further evidence of their type he concludes: 'There is no necessity for assumption of a previously existing costate stage in tuberculate ammonites or of a slender-whorled evolute stage before a stout-whorled involute stage, except to make them arbitrary cycles and lineages; for the evidence generally points to some indifferent root common to both extremes."

Here de Beer notes, as we have seen, that a particular ammonite form begins its life cycle with simple suture lines and later develops complex lines. According to the notion of recapitulation, the early simple lines of a Mesozoic form would indicate that the ancestral adults of a Paleozoic form also had simple suture lines. He simply points out that the arrangement of these suture lines indicates nothing of the kind. Of course, this is quite true. Nature is not obligated to provide us with neat explanations of past events, as protagonists of the recapitulation theory seem to think. Rather, nature proceeds to its ontogenetic destinations along the shortest possible path consistent with efficiency.

One might also point out that any phyletic sequence is easily obscured by homeomorphy and migration; there were a great many of these Cephalopods, some 5,000 species, and in such a mixed crowd it is difficult to say which was the father of which. They had the wanderlust for it should be remembered they were the dominant marine form of the entire world for unthinkable centuries. With such migratory proclivities it is easy to see that the grandparents of one buried in the mud off England's shoreline might have spent their youth cavorting in the seas where now tower the Hindu Kush mountains in central Afghanistan.

There is a recapitulation of earlier stages to be sure, but the application of the law should be tentative. The suture lines suggest and imply, rather than fulfill.

* * * * *

Just as the story of the ancient Egyptians would not be right were the illustrious Ramses family ignored, so does a history of the Mesozoic era go hand in hand with the story of the ammonites. In spite of their brilliant and long career, they came to an unhappy end at the close of the Cretaceous period, as an ignoble climax to a 250-million-year dynasty.

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## Books for Biologists

PREFACE TO EMPATHY, David A. Stewart, 157 pp, $3.75, Philosophical Library, New York, New York, 1956.

Here empathy is thought to be the most important act in the life of human beings who aspire to be persons. The author tries to show that ethics, esthetics and dynamic psychology have common ground in the act of empathy, and in the processes which precede it.

OUR NUCLEAR ADVENTURE, D. G. Arnott, 170 pp, $6.00, Philosophical Library, New York, New York, 1958.

This lucid assessment of the potentialities and hazard inherent in the harnessing of nuclear energy avoids sensationalism and marshals the available evidence of the power for good—or evil—of man's most important scientific advance.

BETTER TEACHING THROUGH ELEMENTARY SCIENCE, Julian Greenlee, 240 pp, $2.50, Wm. C. Brown Co., Dubuque, Iowa.

A realistic account of experiences of teachers and children, as teachers go about their work of helping the children undergo desirable development.

# Reactions of Roots and Stems to Changes in Position

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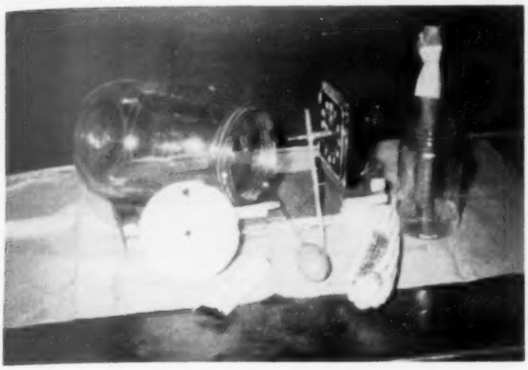

Fig. I. Materials required for the experiment

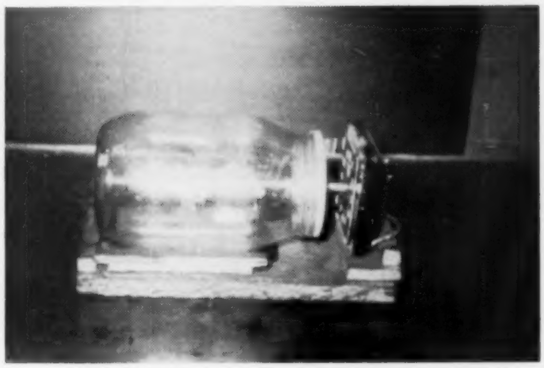

Fig. II. The complete setup

Many experiments and demonstrations have been devised to show plant reactions or tropisms. The following experiment can be set up by the instructor or by a group of students at the beginning of the unit on seed germination and a few days before the start of the unit on reactions in plants.

This demonstration will attract considerable attention, and, as it progresses, will be the topic of extensive observation and discussion, and finally certain definite conclusions may be drawn from the many observations made. In addition to the reactions of the roots and stems to changes in position, the actual growth and development of the seedlings can be observed, including the area of active root growth and the development of the root hairs.

#### Materials Required for the Experiment

1. Wide mouth gallon jar and lid
2. Alarm clock
3. Wood rack to support jar and clock
4. Stick of balsa wood about ½ in. sq. and 12 in. long
5. Duco or other quick drying cement
6. Rubber bulb with long glass pipette
7. Thumb tack
8. Corn seeds
9. Paper towels
10. Absorbent cotton
11. Common pins
12. Water
13. A quart jar for germinating seeds
14. Plastic connection between clock and shaft

### PROCEDURE:

#### A. Setting Up the Apparatus

After all the materials have been selected, the next step will be to arrange the jar, the drive shaft, and the clock in such a way that the hour hand spindle of the clock can be attached to the balsa wood shaft permitting the shaft to turn freely within the jar.

First, with the quick drying cement fasten the large thumb tack inside the gallon jar in the very center of the bottom. This will serve as a support and bearing for the inner end of the shaft.

Then make two holes in the lid of the jar, one in the very center of the lid, about the size of a pencil, to serve as the outside bearing and the connection between the clock and shaft. The other hole should be near the outer edge of the lid, and it serves as a place to insert the pipette for watering the seedlings and cotton. When the experiment is placed in operation, this outer hole should be placed near the top side of the jar. Leave the paper seal inside the jar lid and put the holes in it also. This will aid in holding the lid in position and will prevent the water that collects in the jar from leaking out. The water that accumulates in the bottom of the jar may be re-used for watering the seedlings.

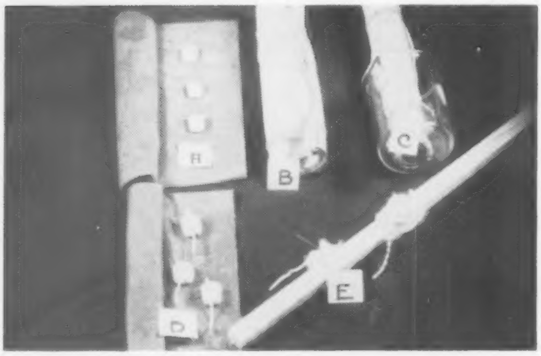


Fig. III. (A) Seeds on towels (B) Towel rolled up (C) Jar with germinating doll (D) Doll unrolled showing germinated seeds (E) Seeds attached to balsa shaft

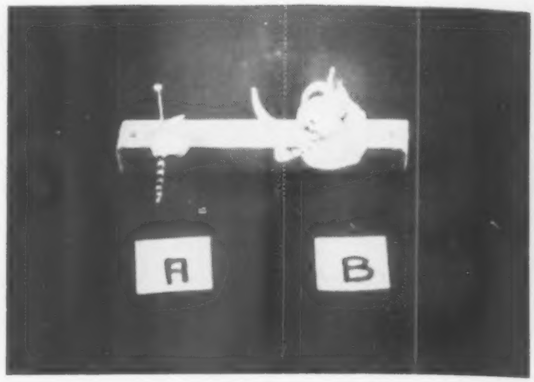


Fig. IV. (A) Roots with ink markings (B) Roots after 24 hours growth

It is desirable to construct a wood rack to support the jar in a horizontal position and to serve as a stand for the clock. This rack, in addition to supporting the jar and clock, will make it possible to move the experiment from room to room as desired.

Next, cut the balsa wood shaft one inch longer than the jar is deep. With a dissecting needle or compass make a hole in the center of one end of the shaft so that it will fit over the thumb tack support bearing and turn freely. Now with a scalpel or sharp knife trim the outer end of the shaft so that it will pass through the center opening in the lid and turn freely between the two bearings.

The connection between the clock and shaft can be made by cementing a piece of plastic rod, that has been flattened like a screwdriver on the free end, to the hour hand spindle. Insert this flattened end into a notch in the wood shaft, thus providing power to turn the shaft. Another method of making this connection is by carefully bending the hour hand in such a pattern that it will point straight out from the face of the clock and turn on center. Insert this projection into the balsa wood shaft and the shaft will turn as the clock runs.

The above explanation is lengthy, but with all the materials on hand at the start the entire setup can be completed in a very short time. Figure II shows the completed setup of the experiment.

### B. Germination of Seeds and Starting the Experiment

The corn seeds may be germinated by placing them in rows on paper towels, rolling the towels into a tight roll to hold the seeds in place and fastening the ends with rubber bands. Saturate the towels with water, and place the roll in a quart jar with about one inch of water in the bottom. The seeds will be kept moist by capillarity, and if kept at room temperature, they will have hypocotyls one-half inch in length in three to five days. Figure III shows progressively these steps. Loss of time will be avoided if the germinating doll is under way while the apparatus is being assembled.

Select four germinated seeds of uniform development and fasten them to the balsa wood shaft, one on each side in order to counterbalance the weight. Force a common pin through the endosperm of the seed and place a small piece of cotton between the seed and the shaft. If the point of active root growth is to be demonstrated, the next step will be to place ink marks on each primary root at ⅛ inch intervals from the point where the root emerges from the seed coat to the root tip. Observations can be made and the conclusions can be drawn on this phase of the experiment after the first twenty-four hours of operation. The procedure and conclusion of this part of the demonstration are shown in figure IV.

After marking the primary roots with ink, insert the inner end of the shaft into the jar and place the hole in the shaft over the thumb tack. Pass the outer end of the shaft through the center hole in the lid and tighten the lid into position. Slide the clock into place so that the extension from the hour hand fits into the notch in the shaft, wind the clock, and your experiment is under way. Fill the pipette with

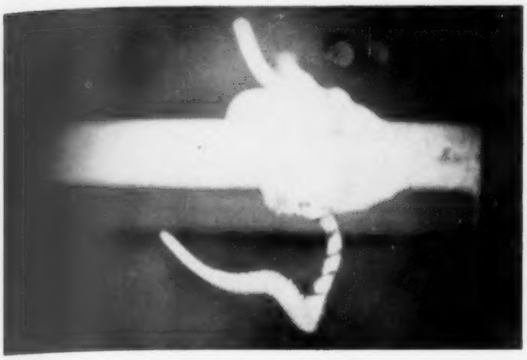

Fig. V. Root hairs

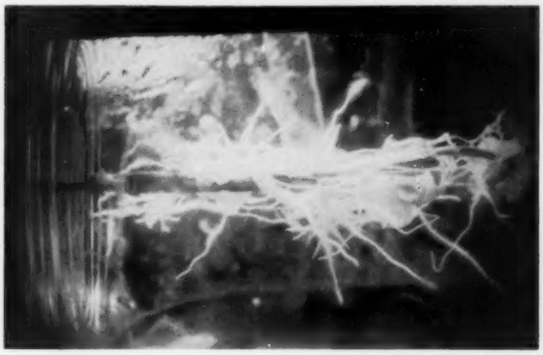

Fig. VI. Results after five days shown inside the jar

water and insert it into the hole near the rim of the lid, which should be near the top of the jar, and moisten the seedlings and cotton. This top hole may be covered with tape when not in use. This will keep the humidity inside the jar higher, aiding the seedlings in their growth, and making conditions more favorable for root hair development. These root hairs will begin to appear in 48 hours along the maturation region of the roots, and their progress can be followed as the roots elongate and as secondary roots develop. Root hair development is shown in figure V.

As the shaft continues to turn the position of the growing seedlings will gradually change. Since the stems are negatively geotropic and the roots are positively geotropic, the continued response to the change in position will result in the following:

A. The roots and stems will grow out from the shaft in all directions.

B. A pronounced spiral twist will be noted in both the roots and stems.

C. In the early development of the seedlings the roots grow more rapidly than the stem, resulting in root spirals that are closer together and more numerous.

The results after five days' growth are shown in figure VI.

The endosperm of the corn seed is large, and if the seedlings are moistened each day, the food supply to the growing seedlings will last for several days. Thus, the over-all duration of the experiment will be from ten days to two weeks. After completion, the apparatus may be stored for another semester. The only needed preparation for the next demonstration will be the germination of the seeds. The results of the experiment after ten days are shown outside the jar in figure VII.

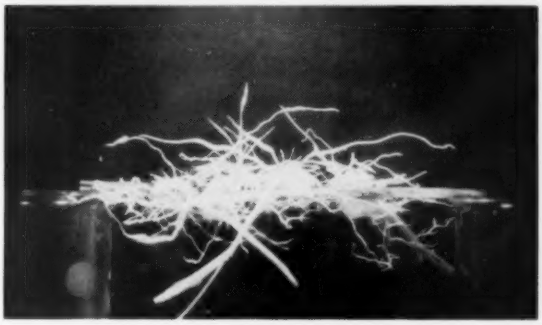

Fig. VII. Result after ten days shown outside the jar

## Summary

1. The response of roots and stems to a continual and gradual change in position is clearly demonstrated.

2. Conclusions on the point of active growth of plant roots can readily be drawn.

3. Beautiful root hair growth can be observed as the experiment progresses.

4. The progress of a growing seedling from the emergence of the hypocotyl and plumule through the seed coat to the development of green leaves and an extensive root system can be followed from day to day.

5. All of the items needed for the experiment can be collected from about the school and from home without cost.

6. Other types of seeds may be substituted if corn seeds are not available.

## Books for Biologists

EXPERIMENTAL PSYCHOLOGY, edited by B. A. Farrell, 66 pp, $2.75, Philosophical Library, New York, New York, 1955.

This series of talks illustrates the sort of work experimental psychologists are pursuing.

# Radiation Biology in the High School Course*

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Since high school biology is an integrated subject including concepts from many areas it follows logically that radiation biology should be added as a "must" to these concepts. The National Science Foundation in outlining its institutes for the summer of 1958 found it advisable to devote twelve entire institutes to the field of radiation biology. This certainly indicates the emphasis the N.S.F. wishes to place on the field of radiation. Furthermore, the Foundation hopes that radiation biology will have an immediate and practical use in high school classes and especially in high school laboratories.

This summer I attended a biology Institute at Marquette University, Milwaukee, Wisconsin, sponsored by the N.S.F. and directed by Dr. R. M. Darnell of the Marquette University Biology Deartment. In this general biology institute several specialists were brought in to lecture to the group on radiation biology. Dr. E. Lawrence Powers, geneticist of the Division of Biology and Medical Research of the Argonne National Laboratories gave several lectures on the subject in which he stressed the nature, effects, and use of radiation. In fact, it was the lectures of Dr. Powers and Father J. P. O'Brien of the Zoology Department of Marquette University that inspired several of us at the Institute to direct our required project to the field of radiation biology for apt high school students.

Sister M. David Campi, P.B.V.M., San Francisco, California, Sister M. Ignatia Donaghue, I.H.M., Monroe, Michigan, and I, after spending a great deal of time in extensive and intensive reading in the field of radiation biology reached the conclusion that it should have a place of prominence in courses of study in high schools. We consequently drew up a unit for high school syllabi, the skeleton outline of which appears in this article.

*This is a report from our radiation biology Institute. Many biology teachers will receive word soon about their acceptance in general and radiation biology programs in various Institutes scheduled for 1959.

We recognized the need of borrowing the basic principles from the fields of physics and chemistry in order that sophomores—to whom biology is most frequently taught—would be able to get a proper understanding of the field of radiation. We also saw that the time allotted to this study would have to be limited; consequently, we decided that the unit could most easily and advantageously be incorporated in and taught along with the unit on genetics, since radiation figures greatly in the field of genetics. We then formulated three basic objectives to cover the scope of the unit.

They are as follows:

1. To get a basic understanding of the principles of radiation and its beneficial application to the field of biology, agriculture, medicine, and the like.
2. To become familiar with the destructive effects of radioactivity and to learn how to overcome and prevent its hazards.
3. To acquire the proper perspective regarding the role of radioactivity in our lives and those of future generations.

In order that high school teachers may have some idea of our approach, the skeleton outline of the unit on radiation that was submitted to the Institute at Marquette University, Milwaukee, this summer is incorporated here.

I. Historical background to the study of radiation
   A. Henri Becquerel (1852-1908)
      1. Discovered that uranium emits invisible rays
      2. Received Nobel prize in 1903 for work on radioactivity
   B. Wilhelm Roentgen (1895-1923)
      1. Discovered that rapid cathode rays in striking a heavy metal emit rays of short wave length
      2. Called the rays X-rays or Roentgen rays
   C. Pierre and Marie Curie (1859-1906 and 1867-1934)
      1. Investigated uranium ores at request of Becquerel
      2. Discovered that pitchblende yielded polonium and radium
      3. Became co-Nobel prize winners with Becquerel, 1903
   D. Ernest Rutherford (1871-1937)
      1. Investigated nature of nucleus of the atom
      2. Discovered alpha and beta rays

II. The atom
  A. Definition
  B. Structure
    1. Nucleus
      a. Protons
      b. Neutrons
    2. Energy levels
      a. Contain electrons
      b. Determine chemical characteristics and activity of the atom
  C. Isotopes
    1. Definition
    2. Discovery by T. W. Richards and F. Soddy

III. Radioactivity
  A. Definition
  B. Kinds of radioactivity
    1. Natural
    2. Induced
  C. Units of measurement
    1. Roentgen (r) unit
    2. Curie
    3. Half-life

IV. Radiation and living things
  A. Radiation and man
    1. Medical uses of radiation
      a. Diagnoses
        1. Tracers
        2. X-rays
      b. Therapy
    2. Detrimental aspects
      a. Radiation sickness
      b. Cumulative factor
      c. Genetic effects
        1. Alteration of gene structure
        2. Influence on activity of genes
        3. Destruction of genes in some instances
        4. Introduction of change in chromosome structure
        5. Approximate cause of sterility if whole body is exposed to large doses
      d. General physiological effects of radiation
  B. Radiation and plants
    1. Beneficial effects
      a. New hybrids developed
      b. Used as tracers for obtaining important data
    2. Detrimental effects
      a. Cause harmful mutations
      b. Accumulated radioactivity detrimental to animals and man
    3. Modifying factors
  C. Radiation and other living organisms
    1. Microorganisms and insects
      a. Beneficial effects
      b. Detrimental effects
    2. Animals
      a. Beneficial effects of radiation
      b. Detrimental effects

V. Problems and hazards of radiation
  A. Radiation sickness
    1. Causes
    2. Symptoms
      a. Loss of appetite
      b. Nausea
      c. Epilation
      d. Diarrhea
      e. Headache
      f. Insomnia
      g. Infections, etc.
  B. Fall out
    1. Description
    2. Types
      a. Near fall out
      b. Distant fall out
      c. Long range or delayed fall out
  C. Dosimetry
    1. Definition
    2. Dosage and distribution
      a. Dose
      b. Distribution
    3. Lethality range

VI. Radiation and you
  A. Control and safety factors regarding radiation
  B. Social implication of nuclear energy
  C. Economic implications of nuclear energy
  D. Contemporary viewpoints regarding radiology

VII. Glossary

VIII. Correlated activities

IX. Suggested laboratory experiments with radioisotopes

X. Bibliography

Anyone interested in the complete development of the above outline or the bibliography may contact Sister M. Henriella Reinders at Cathedral High School, Superior, Wisconsin for this information.

## Brain Blood Barrier

A brain-blood barrier, intended by nature to protect the brain and nerve centers, may also impede or block potentially helpful drugs. Many substances pass much more readily from the blood stream into the fluids of other tissues than they do into the brain and nervous system fluids. Thus far, the barrier can be broken down in experimental animals only by measures so drastic that they are fatal.

The barrier may be made up of two parts. One part consists of the cells in the walls of the brain's blood capillaries, which "demonstrate a uniquely thick and solid arrangement" making them more "leak proof" than capillaries elsewhere. The other part is in a special membrane of nerve cell material wrapped around the brain capillaries. Each part screens certain materials in the blood plasma.

# Everyday Use of the Scientific Method as a Technique in High School Biology Teaching*

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It is easy to lose sight of the objectives of a high school biology session. To get the work done because it is required becomes the object of the student. The drawings and content of the textbook serve as his materials, besides his unique ability to please the teacher (answer *her* questions, do what *she* wants). One would think the prime purpose of the student was to teach the teacher.

Many times the method used in such a course becomes standardized. The student answers questions in or from a workbook, written by adults, which are often meaningless to him. He may also copy drawings from the textbook. This becomes the daily, unchanging routine of the sessions.

The result is evidenced in the motivation of the student and manifested by his academic performance. If he *wants* to please the teacher, and thus receive a high grade, he will comply quite well. If he feels he just needs the credit, and is concerned more with his own individuality than with his teacher's requeses, he may respond to her just enough to "get by." If the student wants to assert his own individuality over the directives of the teacher, he may refuse to comply with any of her requests to the point of failing.

The natural curiosity of the student and the wish of the adolescent to assert his own individuality has been overlooked in all three of these instances. In effect, *he* has been overlooked. This may well be evidenced by the student in an absence of enthusiasm for biology.

I first used the scientific method (object, method, materials, results, conclusions) when I taught the concepts of the physical sciences to high school students of general science. The method worked so well with living things that I introduced it as a method of organization in my biology courses. It pulled all of the many aspects of biology together for the students in a concrete way, adding unity to the field. It also tended to unite the science of biology with the sciences of physics and chemistry.

This entire approach to the teaching of biology is based on the natural curiosity of the student. The materials which stimulate his curiosity can be spontaneous or contrived. Live animals and plants provoke the curiosity of a student easily. Preserved specimens can be used for dissection and observation of the variety of organisms within a group.

The scientific method was recently utilized in this spontaneous way. Students beginning a biology course are eager to use the microscopes. Terry had an aquarium at home and was eager to find out what the water in it looked like under the microscope. He brought some to school. This later led to curiosity about lake water which was procured by one of the students and studied in a similar manner. The students wondered what they would see. Sue volunteered to print the questions of her classmates on the blackboard. She acknowledged each one and listed it under *Object*. Spontaneity and enthusiasm were much in evidence. "Are there living things in the water that we can't see with our eyes?" "What are they like?" "How do they eat?" "How do they reproduce?" "Are they in 'living color'?"

Sue, the recorder, next printed *Method* on the blackboard. The students quickly responded with, "Let's look at the aquarium water under the microscope!" "First, we'll have to learn how to use it." "We can make a drawing of what we see." "We can get some books from the library to answer some of our questions." Sue acknowledged and recorded all of these.

*Materials* was then printed on the blackboard. Our recorder acknowledged Martin's contribution, "Terry's aquarium water." Other students added, "The microscope." "Unlined paper and a 4H pencil for the drawings." I suggested several reference books.

*Presented at the NABT sessions of the AAAS in Washington, December, 1958.

Each of the students then made an individual copy of these lists from the blackboard and proceeded to find the answers to the questions which were quite extensive. These were listed under *Results*. Concurrently, they drew the different animals and plants they saw and labeled them, using the different reference books, including the textbook.

Conclusions were then formulated based on the individual student's results. The students were very penetrating in their aanlyses of *why* a structure is present in an organism. In one class discussion a member refuted another's conclusion that a plant turns toward the light merely because it needs to. This led to hypotheses and finally to observations and investigation. A thrill was evidenced when the students found that this behavior was actually due to plant hormones. They caused more growth to occur on the shaded side, allowing the plant thereby to bend. Thus the precise mechanisms of how and why are not overlooked.

The scientific method can also be used upon the stimulation of a contrived experience. Two potato plants were placed before the students. They were growing in the same kind of soil. All environmental factors seemed to be identical except for one variant. One plant was completely covered from the light. The other was not. The students observed the appearance of the two plants. They wondered why one plant was so much longer than the other. John Tower hypothesized, "Maybe light retards growth." Joan Corley countered, "No, light promotes growth!" We called John's idea the Tower hypothesis, and Joan's idea the Corley hypothesis. The members of the class chose one of the two hypotheses. The Tower hypothesis then became the Tower Theory, and the Corley hypothesis became the Corley Theory. The Tower Hypothesis had few followers. The majority were in the Corley school of thought. Jean volunteered to be recorder. The *Object* of the investigation was to find which theory was truly scientific. This meant the same results had to be obtained after repeated experimentation. The *Method* decided upon was to observe the effects of darkness on other types of plants, with a control (plants which have no environmental factors varied). The materials were the plants, material necessary to shade them, paper and the 4H pencil. The *Results* affirmed the Tower Theory and disproved the Corley Theory. The *Conclusion* that light retards growth was made by several, but to others this still seemed too big a generalization to make. They said, "What about the fungi, like the mushroom? Does light retard their growth?" And so the students will let their natural curiosities carry them into the present investigations in biology. Some of their questions are being studied. Many are not. This can lead to the development of a scientist.

Periodically the students evaluate their progress, individually and in writing. They also evaluate the course so far. What do I like about the course? What do I dislike about it? This gives the student the opportunity to express his satisfaction or dissatisfaction with the sessions. Several valuable suggestions have been made in the past which I have utilized.

With this opportunity for a student to participate actively in his own and in the group's learning situation, he experiences a feeling of importance. When his question is printed on the blackboard, he feels pride in his ability to contribute.

Spelling ability, as evidenced on tests, increases. Frequent pronunciation of terms during class discussions helps the student become familiar with them. Academic performance improves.

The resulting enthusiasm of the students arising with the use of this method is encouraging. Here are some of their reactions:

"It's easier for the students to get a better understanding of biology."

"A new outlook on the way to solve problems."

"A logical way of thinking."

"Shortest way to find the core of the problem."

"When I use it at school, I tend naturally to use it at home." (Improvement of mental health.)

In conclusion, the use of the scientific method in this way is effective in the learning process because the students *want* to find the answers to their own questions. They are self-motivated. Also, an understanding of *how* all the knowledge of the scientific world was and is obtained becomes realized by the student. He begins to feel like an apprentice scientist. The scientific world no longer seems apart from him; he becomes a member of it.

# Biology in the News

**Brother H. Charles, F.S.C.**

HOW SAFE ARE THE CHEMICALS IN YOUR FOOD? Ruth and Edward Brecher, *Redbook*, December 1958, pp. 24-27, 82-83.

More than 400 chemicals and some 100 pesticides are likely to find their way into our diet. This interesting account of pertinent information about these harmful substances in our foods stresses the need for enforcement of the new Food Additives Amendment.

ARE YOU A CANDIDATE FOR HEART DISEASE? Curtiss Anderson, *Better Homes and Gardens*, January 1959, pp. 44-45, 86, 96-97.

Dr. Paul Dudley White answers some frequently asked questions about our most amazing muscle—the heart.

THE HUNT FOR HIDDEN DIABETICS, Patricia and Ron Deutsch, *Saturday Evening Post*, December 6, 1958, pp. 20-21, 75-79.

Many people do not know they have diabetes. How community effort in Fresno, California located many unknown cases may inspire students to initiate a similar program in their own town.

STOP DRIVING YOUR PET CRAZY, Stanley Frank, *Saturday Evening Post*, November 29, 1958, pp. 32-33, 92-94.

Pets reflect the emotions of their masters. Many pets are the victims of their masters' tensions. This article may stimulate discussion about how pets show the effects of improper treatment and how pets can and should be cared for.

THE GENTLEST PETS I EVER HAD, Era Zistel, *Saturday Evening Post*, December 27, 1958, pp. 30, 77-79.

Flying squirrels are seldom tamed. However, they will accept friendly companionship. This article stresses the benefits to the person who makes friends with animals rather than details of the activities of flying squirrels.

TEXAS GRASS IS COMING BACK, John Bird, *Saturday Evening Post*, January 3, 1959, pp. pp. 32-33, 76-78.

An excellent example of the result of effective use of ecological knowledge, large earth-moving machinery and the services of the Soil Conservation Service in transforming areas covered by cactus and thorny brush into productive pasture lands.

FOR NEW THRILLS, C. B. Colby, *Outdoor Life*, January, 1959, pp. 52-55, 68, 91.

Bow and arrow hunting provides thrills and demands more know-how of life in the woods and fields than does any other type of hunting. Some excellent pointers are included in this article.

HOW TO HUNT RABBITS, Ben East, *Outdoor Life*, December 1958, pp. 74-79, 120-121.

Rabbits provide the most sport for the greatest bulk of hunters. This group of suggestions about hunting rabbits will stimulate others from many students.

ANYBODY'S SHORT, Erwin A. Bauer, *Outdoor Life*, October 1958, pp. 64-67, 143-145.

The cottontail rabbit is our commonest furred game animal. This story includes many things about habits of rabbits.

ASPIRIN, EVERYBODY'S WONDER DRUG, T. F. James, *Cosmopolitan*, October, 1958, pp. 58-61.

Americans are taking aspirin pills, at the rate of 500 per second. Most are taken for minor ills. Now they are being used effectively in controlling some major diseases.

FACTS ABOUT FOOD ADDITIVES, George P. Larrick, *Good Housekeeping*, October, 1958, p. 18, 116.

A question and answer presentation about what is added to our foods in relation to effects on our health.

## NSTA MEETING

The National Science Teachers Association will meet in Atlantic City March 31-April 4, 1959. The general theme of the meeting is "Science Education for America: An Appraisal and a Look Ahead." Special features will include workshops for elementary and secondary school-teachers as well as demonstrations of science teaching with "live teachers" and groups of "live students"—primary grades through high school.

For information and program write NSTA, 1201 Sixteenth Street, N. W., Washington 6, D. C.

## Flagellates in Research

What makes the flagellates so useful in research on human vision is the fact that they contain a light-sensitive substance called astaxanthin which is also found in the retina of the human eye, Dr. Wolken explained. Research on the microscopic growing cells under carefully controlled chemical and physical conditions has enabled the Pittsburgh scientists to develop a proposed model for the chemical make-up of chloroplast, the chlorophyll-containing plant material which can convert light energy into chemical energy, Dr. Wolken said. Working from the proposed model, it has been possible to estimate the weight of a molecule of the chloroplast and to calculate the cross sectional area occupied by each molecule of chlorophyll. The algal flagellate, a form of life which has characteristics of both plants and animals, is capable of producing chlorophyll and chloroplast under either natural or fluorescent light, stated Dr. Wolken, and in the dark this process is reversed, resulting in the loss of pigment and chloroplast structure. Chloroplast was found to be a complex pigment-protein structure with a molecular weight estimated at 20,000 to 40,000.

# AO Reports on Teaching with the Microscope

## Measurements through the microscope...or how to clock a speeding protozoan

We don't know who he was or when it happened, but the man who made the first measurement and recorded it, probably became the world's first true scientist. Man has been gathering and recording measurement data ever since . . . virtually nothing escapes his tape measure. The astronomer uses light-years to measure the infinite reaches of the universe; the microscopist uses microns to measure a universe that recedes into infinite smallness; in between lies a vast army of scientists measuring everything on or beneath the earth . . . indeed, the earth itself . . . using every conceivable unit of measurement.

The scientific method requires, essentially, the gathering and recording of data . . . this can be, in itself, an exciting thing. Students can find this to be particularly true as they use the microscope to measure the "unseeable". We hope the following tips on making measurements through the microscope will give your students a new appreciation of this aspect of the scientific method.

### MEASUREMENTS THROUGH THE MICROSCOPE

#### 1. ESTIMATE SPECIMEN SIZE

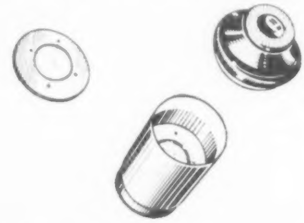
If the field size provided by the objective—eyepiece combination is known, the size of comparatively large specimens can be estimated simply by determining how much of the field the specimen covers. Approximate field sizes provided by the three standard magnifications are as follows:

100X (10X obj., 10X eyepiece) = 1500 microns
430X (43X obj., 10X eyepiece) = 350 microns
970X (97X obj., 10X eyepiece) = 150 microns

To determine field sizes of other low power objective/eyepiece combinations, simply focus on a millimeter scale using oblique illumination (light directed onto surface of scale to reflect off and up into optical system of microscope). You can convert millimeter readings into the microscopists' standard unit of measurement, the micron. One micron is equal to 1/1000 of a millimeter.

#### 2. CROSS-HAIR EYEPIECE

A cross-hair in the eyepiece will mark off the field of view into approximately equal quadrants, thus making it easier to estimate specimen size, particularly if specimen covers less than half the field. Here's how to make a cross-hair disc and insert in eyepiece.



**A.** Select a thin washer of proper diameter (approximately ⅞") to fit inside eyepiece. Use human hair (preferably blonde because it is finest) and model airplane cement to fashion a cross-hair over the washer, see fig. 1.

**B.** Unscrew top lens element from eyepiece. Place washer with cross-hair in eyepiece directly on diaphragm . . . replace top lens element.

#### 3. ESTIMATING SPEED OR MOVEMENTS OF LIVE PROTOZOA, ETC.

Interesting exercises into the realms of relativity and mathematics can be worked out using live protozoa. Observe protozoa under low power and use stop watch to calculate time required for one specimen to traverse entire field or portions of field divided by cross-hair. Microscope magnifies size only, not time. Converting microns per second to the familiar miles per hour results in increased student understanding of the various units of measurement.

#### 4. EYEPIECE MICROMETER

Exact measurements can be made by means of a scale, or micrometer disc, placed in the eyepiece. The divisions in the eyepiece micrometer disc have arbitrary length. The apparent length depends upon the total magnification used. Therefore, before the disc can be used to measure a specimen, it must be calibrated for use with each combination of objective and eyepiece against a stage micrometer. A stage micrometer has divisions of true length. The AO Spencer stage micrometer, Catalog Number 400, has a 2mm scale divided into 200 parts . . . each part measuring .01 mm. Every tenth part on the scale is numbered, see fig. 2. If you want complete information about eyepiece micrometers and stage micrometers just write to: Dept. N58 American Optical Company, Instrument Division, Buffalo 15, New York.

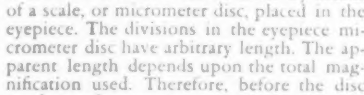


*Fig. 2*

**PROCEDURE**

**A.** Unscrew top lens of the eyepiece . . . insert eyepiece micrometer, *ruled side down* on the diaphragm within the eyepiece. Replace top lens.

**B.** Place stage micrometer on microscope stage . . . focus sharply with 10X objective. Rotate eyepiece and move stage micrometer until both scales are in juxtaposition along the same axis and both scales are even at one end, see fig. 3. Now count the number of arbitrary divisions of the eyepiece micrometer that fall within a specific true distance on the stage micrometer. In fig. 3,


*Fig. 3*

for example, the first 21 divisions of the eyepiece micrometer (Y) fall within 7 divisions of the stage micrometer (X). We can find the calibration constant (C) simply by dividing the true distance (X) by the number of divisions of the eyepiece micrometer (Y); i.e.:

$$C = \frac{X}{Y}$$

$$C = \frac{7(.01)}{21}$$

$$C = .003 \text{ mm; or 3 microns}$$

Now, using this as an example, if a specimen is measured against the eyepiece micrometer scale and found to span, let us say, 10 divisions, we can determine its size by multiplying the number of divisions it spans by 3 microns, i. e. 30 microns.

**NOTE:** The eyepiece micrometer must be calibrated at each magnification. Once calibrated, the constant should be noted and then the eyepiece micrometer need not be recalibrated if those same magnifications (and tube length) are used.

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